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For : METHOD FOR TRANSMITTING DATA STREAM VIA WIRELESS MEDIUM ACROSS A WIRELESS NETWORK AND A WIRELESS NETWORK

**CLAIM OF PRIORITY**

Commissioner for Patents
U.S. Patent and Trademark Office
Customer Service Window, Mail Stop PCT
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

Applicant hereby claims the right of priority granted pursuant to 35 U.S.C. 119 and 365 based upon Japanese Application No. 2003-004498, filed January 10, 2003. The International Bureau already should have sent a certified copy of the Japanese application to the United Stated designated office. If the certified copy has not arrived, please contact the undersigned.

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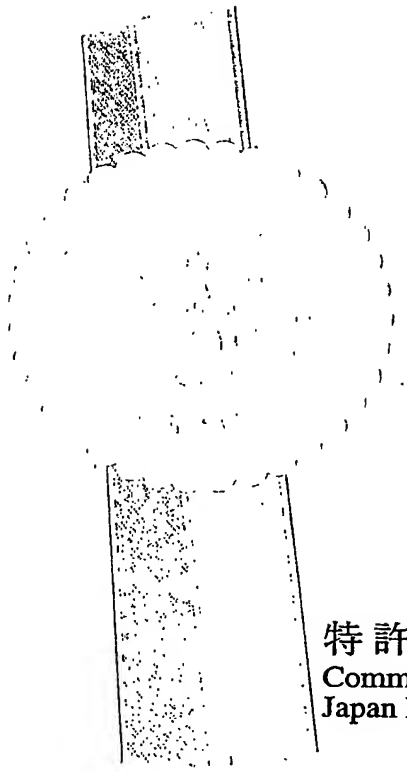



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【書類名】　外国語明細書

【発明の名称】　Methods and System to request and maintain wireless medium dedication for real-time data delivery across a wireless network

【特許請求の範囲】

(1) A system that enables a network device to facilitate QoS data transmission in which the timing to initiate transmission by the device is coordinated, comprising of:

(i) A rate controller to police the emission of traffic stream into the transmission queue such that it does not overuse the dedicated bandwidth and violates the pre-negotiated transmission rate.

(ii) A Traffic Shaper to mould the emission rates of all traffic streams into a transmission queue, such that it can be served in First-In-First-Out fashion without introducing bias towards any stream.

(iii) A Transmission Controller to generate the necessary signals to control the transmission of a packet at the transmission queue and to release a transmission permit.

(2) A system that enables a network device to facilitate QoS data transmission, in which the timing to initiate transmission by the device is determined autonomously by the device, comprising of:

(i) An Admission Controller to grant transmission permission to a newly initiated traffic stream such that transmission channel is not overloaded by the admission of the new stream.

(ii) A Transmission Controller to generate the necessary signals to request for transmission permits and to control the transmission of the packet at the transmission queue.

(iii) A Transmission Permit Generator to generate a transmission permit for a device to initiate transmission.

(3) A method to ensure no bias is introduced by combining all the data units of all traffic streams that are to be transmitted in a coordinated manner at the transmission queue, in order to allow data units to be transmitted in a timely and First-In-First-Out fashion, when granted a transmission permit, comprising the steps of:

(i) Performing rate control to police the emission rate of a traffic stream into the transmission queue such that it does not violate the pre-negotiated rate.

(ii) Performing traffic shaping to mould all the emission rates of the traffic streams into a transmission queue such that it can be served in First-In-First-Out fashion without introducing unfairness to any stream.

(4) A method to achieve traffic shaping as claimed in part (ii) of claim 3 and part (i) of claim 18 comprising the steps of:

(i) Determination of a periodicity interval for the operation.

(ii) Computation of the average number, or size of the data units that are to be transmitted in duration of the periodic interval in order to satisfy the QoS requirements of the traffic stream.

(iii) Compute the variation of the average number, or size of the extra data units that are permitted to be transmitted during the periodic interval duration, in order to satisfy the QoS requirements of the traffic stream that are not generated at a constant bit rate calculated over the periodic interval.

(iv) Compute the accumulated number, or size of data units of the traffic stream that have been permitted, but not yet transmitted, from the beginning of the stream transmission. This value is obtained by adding the value as computed in part (ii) at the beginning of each periodic inte

rval, while subtracting a unit for each transmission that is made.

(v) Determine the number or size of data units of the traffic stream that are permitted to enter the transmission queue during the current pe riodic interval. This value is determined at the beginning of each perio dic interval by adding the value computed in part (ii) to the value of o btained in part (iv) at the end of previous periodic interval if the val ue is not greater than zero. Otherwise the values computed in parts (ii) and (iii) are added to the value obtained in part (iv) at the end of pr evious periodic interval.

(5) A method to determine the periodicity interval as claimed in part (i ) of claim 4, when the transmission permit given to a transmission queue has a constant duration comprises the step of:

(i) Compute the number or size of data units can be transmitted in th e constant duration.

(ii) Compute the duration required for the transmission queue to be f illed with the number or size of data units computed in part i.

(6) A method to have only one Traffic Permit Generator for multiple tran smission queues is to implement the generator process as two stages fini te stage machine that comprises of:

(i) A variable associated to a transmission queue indicating the rema ining number of fixed slot that the transmission medium need to be remai ns silent before a transmission permit can be granted to the transmissio n queue.

(ii) A variable associated to a transmission queue indicating that th e transmission queue is having a pending request for transmission permit .

(iii) An IDLE stage to decrement the variable in part i if it is non-

zero at each slot interval and grant transmission permit when a transmis sion queue is having pending request for transmission permit and the res pective variable in part i is zero. A transition from IDLE stage to BUSY stage is performed when granting transmission permit is not allowed.

(iv) A BUSY stage that is to stop decrement the variable in part i at each slot interval. A transition from BUSY to IDLE stage is performed w hen the transmission medium has been IDLE for prefix duration.

(7) A method for of reducing wireless medium occupancy contention where the wireless stations content for transmission bandwidth by dividing int o 2 distinct periods of wireless medium occupancy contention, the 2 dist inct periods are:-

(i) Pre-Scheduled medium occupancy period where transmission with con tention and transmission without contending is allowable to wireless sta tion that has previously gain medium occupancy period through successful contention in the wireless medium occupancy contention period; and

(ii) Medium occupancy contention period where wireless stations can c ontend for wireless medium occupancy.

(8) A method to bound selective contention period, as in claim 7, by all owing a central controller of the wireless network where wireless statio ns perform selective contention by broadcasting a data message with the following parameter:-

(i) A bit field indicating start and end of the selective contention period,

(ii) A numerical representation indicating the time wireless stations can begin contending and reserve for medium occupancy period in current and next selective contention period, and

(iii) A numerical representation indicating the durations of the sele

ctive contention period.

(9) A method for all stations to generate the selective contention perio d, as in claim 7, within the wireless network controlled or coordinated by a central controller on reception of a signal or message indicating t he beginning of the selective contention period and by retrieving the fo llowing pre-stored numerical representatives from the message consisting of :

(i) A representative indicating the time wireless stations can begin contending and reserve for medium occupancy period in current and next s elective contention period, and

(ii) A representative indicating the durations of the selective conte ntion period.

(10) A method to signal contention based medium occupancy reservation wi thin the wireless network using a numerical represented counter or point er to indicate the beginning of contention time and duration within a bo unded period where the bounded period is described in claim 7, to contro l contention for medium occupancy reservation.

(11) A method to prevent wireless medium contention during a period occu pied by wireless medium occupancies belonging to other stations through successful contention based reservations by having a transmission record s of a bounded period of time where the transmission records are managed by individual station within the wireless network and the records compr ises of :-

(i) Medium Occupancy Start time of all data streams of the host wirel ess station;

(ii) Medium Duration of all corresponding data streams of the host wi

reless station;

(iii) The start time of a continuous period of wireless medium occupancy of other wireless stations observed by the host wireless station; and

(iv) Durations a continuous period of wireless medium occupancy of other wireless stations observed by the host wireless.

(12) A system for reserving bandwidth in a wireless network where medium occupancies generated by transmitting stations using contention means by allowing transmission records, as in claim 11, to be updated in a distributed manner comprises of medium occupancies periods of data streams to be transmitted by the host station and transmission silence period observed by the host stations due to medium occupancy period allotted to other stations.

(13) A method to reduce bandwidth wastage due to contention of wireless medium occupancy reservations in the medium occupancy contention period by freeing up the bandwidth for contention comprises the steps of :-

(i) Appending new blocks of transmission silence period separated only by contention time to form a larger transmission silence period; and

(ii) Removing contention time of Medium Occupancy Period between transmission silence periods or another Medium Occupancy Period.

(14) A method to reserve medium occupancy period for next selective contention period without transmitting bandwidth reservation in subsequent selective contention period by sending medium occupancy reservation parameters in the last data packet in current medium occupancy period where the bandwidth reservation parameters consists of :-

(i) Repeat Flag to indicate that the reservation of wireless medium o

ccupancy time as specified in following parts (ii) and (iii) to be removed or added in the next bounded period;

(ii) A time to indicate the transmission start time measured in reference to the beginning of the bounded period; and

(iii) A representative to mark the duration of medium occupancy time as in the above part (ii).

(15) A method to remove reserved medium occupancy time in the pre-scheduled medium occupancy period by not transmitting in the reserved medium occupancy period and allowing the other wireless station to content for transmission by using the updates of transmission records of stations in the wireless network.

(16) A method to remove reserved medium occupancy in the pre-scheduled medium occupancy period by transmitting a null packet to signal to other stations to content for medium occupancy within the pre-scheduled medium occupancy time.

(17) A system allowing other stations in the wireless network to content for medium occupancy time released by the station by performing individual station transmission record updates from the received null packet from the station releasing medium occupancy.

(18) A method to mould the emission of data units in a short burst in order to reduce the occurrences of collision with other streams or streams from other network devices in a same network that transmission are not being coordinated by a coordinator comprises the steps of:

(i) Performing traffic shaping for the data emission to transmission queue; and

(ii) Requesting Transmission Controller to generate a signal to reque st for transmission permit.

(19) A method to determine the timing for the Transmission Controller as claimed in claim 2 part (iii) or claim 18 part (ii) to generate a signa l to request for transmission permit which is less likely to collide wit h other transmission comprises by monitoring the status of transmission queue such that the signal to request for transmission permit is only ge nerated if there are enough data units to be transmitted upon receiving transmission permit with the condition that the delay of the signal gene ration does not cost the lifetime of any data units to be expired.

(20) A method for the stations to content for medium occupancy medium wi thin the bounds of a selective contention period, as mentioned in claim 7, using a distributed and self regulated control states where the contr ols states comprises of :-

(i) Beginning of Selective Contention period state where the central controller send a message comprises of parameters illustrated in claim 8 and the other stations wait for the successful reception of the said me ssage;

(ii) Pre-Allotted Station Contention state where stations with prior successful contentions in preceding selective contention period contend are allowed to content at specific time based on transmission record, as in claim 11, for wireless medium occupancy time;

(iii) Contention Reservations state is a state where stations can con tend and reserve for medium occupancy in current and next selective cont ention period respectively. Stations participating in the selective cont ention period will also update the contention schedule for medium occupa ncy time of successful medium occupancy time period executed by other st

ations in this state;

(iv) Stations with a successful contention will be in the contention access rights granted state where data packets of a data stream are transmitted;

(v) Stations may traversed through the Advance Contention Avoidance Active state, within the state described in the above part (iv) if said transmitting station choose to reserve medium occupancy in the next selective contention period; and

(vi) After transmitting all data packets reserved for the medium occupancy time in the successful contention as in the above part (iv), the transmission record of the station is updated in the Update Transmission Silence Period Active state.

【発明の詳細な説明】

【発明の属する技術分野】

This invention is to equip a network device with QoS awareness system process to serve traffic streams in a coordinated manner. This invention also increases QoS awareness and throughput efficiency of traffic streams transmission by coordinating stream transmission and reduce the number of collision for contention based medium access mechanism.

【従来の技術】

In prior art, the timing to obtain transmission permit for stream transmission that is not being coordinated are not base on the stream requirement. It will try to request for transmission permit without any other further consideration if the queue is not empty. Furthermore, the permit is granted based on priority as described in [2] and some random periods as described in [1].

[1] International Standard ISO/IEC 8802-11 : 1999 : ANSI/IEEE Std 802.11, 1999 Edition " Part 11: Wireless LAN Medium Access Control (MAC) and (PHY) Specifications

[2] Draft Supplement to International Standard ISO/IEC 8802-11 : 1999 : ANSI/IEEE Std 802.11, 1999 Edition " Part 11: Wireless LAN Medium Access Control (MAC) and (PHY) Specifications (draft 3.0)

【発明が解決しようとする課題】

Based on IEEE802.11e Enhanced Distributed Coordination Function (EDCF), the contention for each continuous packets delivery within a particular time frame causes non-deterministic data packets arrival at the receiver end. Such occurrence of contention is rather prevalent if there is more than one stream of the same priority are admitted into the Basic Service Set (BSS). Contention may occur during each time the station of the same priority content for medium dedication time. The number of contentions depends on the amount of bandwidth allotted to stations and the number of station within the BSS based on the maximum available bandwidth within BSS. Furthermore, the QoS requirement of the transmission streams is jeopardized when the timing to request for transmission permit is not coordinated and guarded. Furthermore, changes to incur collision are higher and overhead are bigger if transmission request is being initiated too frequent.

Complicated LSI implementation is required at the network device in order to preserve the QoS Requirement of individual stream if transmission permits for traffic streams that are to be served in the coordinated manner are being given in aggregated mode.

【課題を解決するための手段】

The invention solves the problems by providing a systematic process to equip the network device to become QoS awareness; a means to reject admission of stream that will cost transmission medium to be overloaded; a means to shape the emission rate of data units in a form of short burst in order to reduce the number of transmission permit required; a means to generate transmission permit to serve multiple transmission queues concurrently; a means to transmit data units of all the traffic streams in the manner that QoS requirement is not being violated; a means of creating a bounded period called the selective contention period for controlled contention of wireless medium occupancy time; a system where the stations and the central controller contend for wireless medium at a selected time in every selective contention period depending on the traffic conditions; a means for the stations and central controller to have a distributed scheduling of transmission by keeping a transmission records at each stations; a means to update the transmission records; a means to reserve and delete scheduled medium occupancy time within the selective contention period. a system to reserve and delete schedule medium occupancy time using contention based wireless medium occupancy access method.

Operations of the invention is as follows:

With the present invention, all traffic streams with transmission being coordinated are being rate controlled and shaped before emitting into a single transmission queue. Data units of all traffic streams in the transmission queue are being served in First-In-First-Out fashion. On the other hand, for traffic streams with transmission not being coordinated are being admission controlled and categorized before emitting to their respective category transmission queue. Data units in a transmission queue

are only permitted for transmission when transmission permit for that q ueue is granted. Furthermore, their respective Transmission Controller o f a transmission queue is coordinating the transmission process.

In the event, application data streams gain access to the wireless mediu m using contention based mechanism at the wireless medium control layer, it is possible to selective choose the contention period for data strea m this is admitted into the wireless network. Selective contention for a ll wireless station can begins after detecting the selective contention start indicator from the central controller of the wireless network. Thi s indicator is broadcast periodically at the beginning of the selective contention period. The stations in the wireless network controlled by th e central controlled in a distributed manner updates the transmission ti me of other stations as well as it's own. With this transmission records , the stations can determine the optimal time to contend for wireless me dium and thereby reducing the contention time within the wireless networ k. The stations can reserve wireless medium by contending using any con tention methods in current selective contention period and automatically reserve for the same medium occupancy time in the next selective conten tion period. Deletion wireless medium reservation is performed by simply not transmitting data packets at scheduled transmission time. All trans mission and non-transmission period at pre-scheduled time will be automa tically updated in the transmission records maintained by individual sta tions within the wireless network.

【発明の実施の形態】

In the following description, for purposes of explanation, specific numb ers, times, structures, protocol names and other parameters are set fort h in order to provide a thorough understanding of the present invention.

The following paragraphs give an exemplification of how the invention can be implemented. However, it will be apparent to anyone skilled in the art that the present invention may be implemented without these specific details. In other instances, well-known components and modules are shown in block diagram in order not to obscure the present invention unnecessarily.

For a thorough understanding of the invention, here below, some operation sequences, information data structures and techniques for calculation are given. Certain data structures are used and they only serve as an example of the implementation of the present invention. It is obvious to the person skilled in the art that in real implementation, new information could be added, and certain parts could be omitted depending on the actual situation they are used in.

In order to rapidly adapt to the transmission conditions of a wireless medium, Quality of Service (QoS) support should be enabled at the lowest possible layer of the 7-layer OSI reference model.. Figure 1 shows a systematic process to facilitate QoS for transmission over a wireless network. Initially the traffic stream needs to be classified according to the manner in which it needs to be served, as marked by literal 101. The time at which data transfer is initiated can either being coordinated by a centralized coordinating entity or determined by an autonomous means. Parameterised or prioritised QoS streams can be served by either: coordinated transfer, or autonomous transfer, depending on the choice of the network device or setup.

For traffic streams that are to be served in the coordinated manner, the emission of traffic is to be rate controlled (103) and shaped (104) ind

ividually, before being admitted to the transmission queue. By doing so, data units can be transmitted in First-In-First-Out (FIFO)manner withou t introducing a bias towards any traffic stream. Furthermore, it facilit ates data transmission without the need for making a decision on the dat a unit to be transmitted when a transmission permit is granted. This pro cess is especially useful when the transmission permit is dedicated to a network device, without specifically indicating any traffic stream. The Traffic Shaper shapes the quantity (measured in terms of either: a) the number, or b) the size) of data units that are permitted to be admitted to the corresponding transmission queue. The first process for Traffic Shaping (104) is to determine a service interval for each transmission queue. The service interval is defined asthe duration between successive dedications of transmission-permits that is required by a transmission queue in order to achieve QoS requirements for all admitted streams. In order to compute the service interval, first determine the quantity of d ata units, S, that are to be transmitted from the queue within a specifi c interval, I. Then compute the duration, D, that is required on the tra nsmission medium to fully transmit one data unit considering all the ove rheads. Then compute the total duration required to transmit all the dat a units that are to be transmitted during I, represented as T, where: T = S * D. Using the value T, above, compute the minimum number of transmi ssion permits required, P.. Finally, the result obtained from the divisi on of I by P is the value of the service interval. After determining the service interval, the values of: a) Service_Credit, b) Service_Negative _Credit and c) Service_Count need to be computed.

Service_Credit is defined as the average quantity (measured in terms of number or size) of data units that can be admitted to the transmission q ueue within a Service Interval. This is computed as the product of the s

ervice interval with the sum of the data rates for all admitted traffic streams. Service_Negative_Credit is defined as the surplus quantity of data units that can be admitted to the transmission queue, within a service interval. It is used to smooth the traffic that is generated at burst without introducing excessive queuing delay. The third variable, Service_Count is the accumulated number or size of data units of the traffic stream that are permitted to be transmitted but have not being do so from the beginning of the stream transmission. It is being initialised to zero before any data units is emitted into the transmission queue. At the beginning of each periodicity of service interval, Service_Credit is added onto the existing value of the variable. After each transmission, a unit is being subtracted from the variable.

At the periodicity of service interval, the quantity of data units, N that are permitted to admit into the transmission queue during the current periodic interval is to be determined. If the value of Service_Count at the end of pervious periodic interval is greater than zero, then N is equal to the sum of Service_Count, Service_Credit and Service_Negative_Credit. Else, N is equal to the sum of Service_Count, Service_Credit only. Then this number is used to guard the emission of data units into transmission queue.

Finally, Transmission Controller (108) is to convert transmission permit to control signal (107) for controlling data transmission, which is also generates necessary signals or control frames to release excessive transmission permit base on transmission queue status (106).

For the traffic streams that determine their transmission time autonomously, each stream needs to be admitted by the admission control unit (112

). The admission control unit determines whether admission of the stream will require more resources than are available in the network and based on this calculation, it will decide whether to accept or reject the str eam. The admission control unit (112) requires two inputs, namely: a) th e estimated data rate of the traffic stream, and b) bandwidth available in the medium prior to admitting the stream. The data rate of a traffic stream can be estimated by monitoring the number of data units and their size at the input terminal of the Traffic prioritiser (114). A station can estimate the bandwidth available in the medium by monitoring it own transmission and the setting of its Network Allocation Vector (NAV). Fur thermore, the emission rate is to be mould in a from of short burst in o rder to reduce the occurrences of contending for transmission permits wi th other streams or stream of other network devices in the same transmis sion network. For Traffic Shaper marked by literal 116, it is having the same functionality as describe for the traffic shaper marked by literal 104 with a minor modification on the method to determined the required service interval. The service interval is to be determined as a interval of transmission permit dedication that is able to maintain QoS Requirem ent of all streams in the respective transmission queue. First is to obt ain the duration of transmission permitted, E, when given a transmission permit. Then, compute the quantity of data units, F that can be transmi tted in duration E. The service interval is the division result of E ove r the rate that data units are emitted to the transmission queue.

Transmission Controller (118) is to control the transmission of the pack et at the transmission queue and generate necessary signal to the Transm ission Permit Generator to request for transmission permit. Request_To_T ransmit signal (120) is being generator to the Transmission Permit Gener ator when the respective transmission queue is non-empty and no pending

signal request is being generated. Transmit Permit Generator logic can be represented by a two stages Finite State Machine as shown in Figure 2 with three variables associated with each transmission queue. The first variable, A is to indicate the remaining number of fixed slot that the transmission medium need to remain silent before a transmission permit can be granted to the transmission queue. The second variable, W is to indicate that the transmission queue is having a pending request for transmission permit. It is set to true when Request_To_Transmit signal (205) is being received and set to false when Clear_To_Transmit signal (206) is generated. In the IDLE stage (201), at each slot interval, A is being decremented by 1 if it is non-zero. Furthermore, when A is zero and W indicating there is a pending Request_To_Transmit signal for the respective transmission queue, Clear_To_Transmit signal is to be generated. A transition from IDLE stage to BUSY stage is required when the transmission medium is detected to be busy. In BUSY stage (202), A is stop from decrementing. When the transmission medium is idle for a pre-fix duration, a stage transition from BUSY to IDLE is to be performed. During that transition, A is to be recomputed. With that, only a single Transmission Permit Generator is required to serve more than one transmission queue.

Figure 3 gives an exemplification of selective contention, as disclosed in this invention, to ensure subsequent zero contention period for transmission of data packets belonging to a data stream after a successful reservation of medium occupancy based on contention method. For the purpose of a better description of this invention, Figure 4 should be used as a reference for a better understanding of the operations of Wireless Stations and Wireless Central Controller in a wireless network within Selective Contention period.

Figure 4 gives a description of the relationships of other sub-periods within one selection contention period, marked by literal 401. Selective Contention Period timing relationships depicted in Figure 4 would be a good reference when the embodiment related to Figure 4 and 5 is read with the HMSC in Figure 3.

Within one contention period, there are 2 sub-periods; (i) Pre-scheduled medium occupancy (403) and (ii) Medium Occupancy Contention (404). The Pre-Scheduled medium occupancy period is used for data transmission for stations that have won the contention in (404) of previous Selective Contention period. The pointer as indicated as SCB_Ptr, marked by literal 405, is computed from the Selective_Contention_Backoff field of Selective_Contention_Information data structure. The Contention back-offs adopted by each station could result in wireless medium contention, marked by literal 406, after all stations begin to content for data transmission rights. It is possible to have plural number of contentions (406) within the medium Occupancy Contention period.

With reference to claim 7 of this invention, the high level message sequence chart (HMSC) gives a typical life cycle of selective contention period occur within a wireless network where wireless stations content for rights to transmit. The rights to content are made known to all stations by having a central controller broadcasting a message containing timing parameters described in the Selective_Contention_Information structure, during the process marked by literal (302). The information in the data structure, Selective_Contention_Information, provides an indication where the contention for the 1st transmission of data stream can take place within one selective contention period. Broadcasting of this message indicates the beginning of selective contention period or it can also be

used to indicate the end of the selective contention period, based on th e values of the Start_n_End parameter in the Selective_Contention_Inform ation. This message is broadcast at the beginning of the Selective Conte ntion Period and may be added at the end of the Selective Contention Per iod and before the conditions marked by literal 301.

The message used to indicate the beginning of selective contention perio d comprises of at least the following parameters:-

```
Selective_Contention_Information
{
Start_n_End;
   /* A  bit field indicating start or end of Selective Contention Perio
d */

Selective_Contention_Backoff;
   /* a data field indicating length of time the wireless stations, with
out prior medium occupancy grant, must wait before contending can starts
. Contention for bandwidth reservation is only allowable to the admitted
 data streams. This field is measured in unit of time from the beginning
 of the broadcast of Selective_Contention_Information message to the tim
e where contention of 1st medium occupancy request can take place */

Duration of Selective Contention;
     /* duration of Selective Period */
}
```

It is possible to implement by appending all or part of the Selective_Co ntention_Information parameters in message format (1) to existing data f

rames such as part of the beacon frame described in the IEEE802.11 specification [1]. Another way of implementing Selective Contention is to append all or part of the parameters of Selective_Contention_Information message in the form of information element that could be transmitted by appending to the IEEE802.11 beacon frame. These beacon frame with the Selective_Contention_Information message that the information element is broadcast by the Medium Occupancy controller of the Wireless network it governed periodically. Some of the parameters such as Duration of Selective Contention can be implemented as a variable shared by all stations within the wireless network through SNMP's (Simple Network Management Protocol) Management Information Based (MIB) value.

After receiving the message in (302), all stations in the wireless network are in the Pre-Alloted station Contention Active state, (303). All stations within the control of the wireless network shall only transmit data if there is prior wireless medium occupancy won as a result of contention from previous selective contention period, (304). The precise time to transmit data packets from the data stream is provided by the values stored in the Medium Occupancy vectors: Time for transmission indicated by M_O_Vec[n] and transmission duration indicated by M_O_Dur[n]. In the event, the station decides to cease data transmission in the pre-Alloted Station Contention Active state, process (316), the station can choose to cease transmission or to send out a NULL data packet to indicate that the station has given up the Medium Occupancy time the station reserve in previous Selective Contention period.

For Stations taking part in obtaining medium occupancy during this selective contention period, transmitting stations must observe and keep a record of the m instances of Transmission silence period and medium occupa

ncy period of a specified data stream admitted to the wireless network g overned by a central medium occupancy controller. The exemplification of this record described in this embodiment is

Transmission Record{
M_O_Vec[n];　/* Medium Occupancy Start time measured from the beginnin g of Selective_Contention_Information to the start of Medium Occupancy t ime for stream n */

M_O_Dur[n];　/* Medium Occupancy Duration or End time */

S_Vec[m]; /* Transmission Silence Start Time of instance m */

S_Dur[m]; /* Transmission Silence Duration or end time of instance m */
}

Stream Transmission time parameters is the time where the data packets o f the specified data stream are scheduled to contend for medium for tran smission. Transmission Silence time parameters are the time where the st ation should not content for the medium occupancy for transmission. Tran smission Silence vectors, consisting of S_Vec[n] and S_Dur[n], are conti guous transmission block separated only by time periods due to contentio ns or Medium Occupancy Vectors. Medium Occupancy Vectors comprises of M_ O_Vec[n] and M_O_Dur[n]. Transmission Silence time are time observed by the stations not transmitting data at the specified time from transmissi ons from other stations. In IEEE802.11, this value can be reflected in t he Duration/ID field [1].

Transmission of data based on medium occupancy gathered from the Station

Transmission record can take place in (304) if medium occupancy content ion is successful by the station in the previous Selective Contention pe riod. Transmission data packets, in HMSC state marked by literal (304) t ake place in (403) of the Selective Contention Period timing relationshi p depicted in Figure 4. Based on the Selective_Contention_Backoff of the Selective_Contention_Information, all stations compute and keep a copy of SCB_Ptr (405) for the Selctive Contention Period and begin to content for 1st data transmission of the stream admitted to the wireless networ k. Contention for Medium Occupancy reservation, as shown in the HMSC in Figure 3, can start by the station if station us in the condition marked by (305). Stations wishing to have the 1st transmission of data packets from the admitted streams will begins contending for Medium Occupancy a s in (307).

Contentions and transmissions of data in a successfully contended wirele ss medium occupancy period during the Medium Occupancy Contention period as in (404) shall be allowed to be repeated in the Pre-Scheduled Medium Occupancy period in the next selective contention period (401). The sta tion with a successfully contended medium occupancy in the period as mar ked in (404) will be in the Contention Accesss Rights Granted condition (308) and allowed to transmit data packets, in processes marked by liter al (311) and (313). Process marked by (311) will be allowed to transmit up to (n-1) packets and process (313) transmit the $n^{th}$ packet, assuming there are n (where $n > 1$) data packets for transmission for the medium o ccupancy period granted from the successful contention. After transmitti ng (n-1) data packets, the transmitting station of the medium occupancy period may choose to be in the state marked by literal (312). In the (31 2) state, the station may specifically asked for similar amount of mediu m occupancy time in the next selective contention period (401) by perfor

ming tasks in (314) and (315). In process marked by literal (314), station may choose to consolidate the transmission of data packets of the data streams admitted won in the Medium Occupancy Contention Period, (404) for the next transmission. Process (315) will make the necessary control information to indicate that the wireless occupancy is needed to the central controller by appending the information in the last data packet transmission. The information sent in (315) is depicted the Next_Transmission data structure.

```
Next Transmission {
Repeat_Flag;  /* A bit field to indicate to all stations and
                 central controller that the next Selective
                 Contention Period should have the specified
                 Medium Occupancy period or to have the Medium
                 occupancy period release*/
Stream Transmission Start;   /* time measured from the beginning
                                of Selective_Contention_Information
                                transmission */
Stream Transmission Duration or End time;
                /* End time of transmission of the data stream in
                   unit time or measured from the beginning of
                   Selective_Contention_Information */
};
```

Both wireless central controller and wireless stations within the wireless network controlled by the said wireless central controller must keep a list of transmission by other stations during Selective Contention Period by process marked by (310) during the Update Transmission Silence Period active condition (309). In the IEEE802.11, this is updates knows as

the Network Allocation Vector [1] updates.

On detecting the end of the Selective Contention Period, as detected in process (306), either it is through time out of the central timer or thr ough the time out created by the station through the value in the Durati on of Selective_Contention parameter of the Selective_Contention_Informa tion, contention for wireless medium must ceased. The central controller would be in the process marked by (306), will then perform the updates based on the medium occupancy registered in the Pre-Schedule Medium Occu pancy Period and the Medium Occupancy Contention Period, to create a new Selective_Contention_Backoff parameter for the next selective contentio n period. A new broadcast consisting of the new Selective_Contention_Bac koff parameter will be broadcast to all wireless stations in the beginni ng of the Selection Contention Period.

Figure 5 shows the detail depiction of the transmission silence and spec ified stream transmission being updated at the station and the central c ontroller that is responsible for broadcasting the data in the Selective _Contention_Information to the stations in the wireless network the cent ral controller controlled in the Pre-Scheduled Medium Occupancy Period f or the next Selective Contention Period. This is to eliminate the conten tion time wasted in the Medium Occupancy Contention Period, (404), which will form part of the Pre-Scheduled Medium Occupancy Period in the next Selective Contention period.

The implementation in Figure 5 assumes that the Transmission Silence vec tor and Medium occupancy updates are based on inter-leaved transmission silence and medium occupancy period. The update process in Figure 5 can begins, (501), when the end of the Selective Contention period. The cent

ral controller and the stations within the wireless network can use the same flowchart in Figure 5 to create Selective Contention Reservation Schedule within the Pre-Scheduled medium Occupancy period for subsequent Selective Contention Period. Selective Contention Reservation Schedule at the Stations consists of Silence Transmission vector consisting of S_Vec[m] and S_Dur[m] parameters of Transmission Record structure and Medium Occupancy vectors of stream n consisting of M_O_Vec[n] and M_O_Dur[n] of the Transmission Records structure. For each Selective Contention Reservation Schedule update, the total number of non-zero Silence Transmission vectors and Medium Occupancy Records kept by both station and central controller are updated. Process block (503), determines the last point of Transmission Silence of the last fragment and the Medium Occupancy vector nearest to the consecutive Transmission Silence fragment or the next Medium Occupancy vector.

If next vector to be updated is a Transmission Silence fragment, the new Transmission Silence Fragment is updated based on the condition if the preceding vector is a Medium Occupancy vector or Transmission Silence Vector. If current vector is a Medium Occupancy vector, process path indicated in 504 will be selected. Medium Occupancy vector is updated according to process in 506 and 509.

In the case of current vector is Transmission Silence Fragment, the updates of Transmission Silence Fragment is updated according to (507), if the preceding vector is Medium Occupancy vector. Else if the preceding vector is a Silence Transmission vector, the current vector will be updated and the duration of current vector will be added to the preceding Silence Transmission Vector as in (508). The current vector is destroyed as indicated in process (510) by initialising to null.

Figure 6 give an example of 3 stations contending selectively for the wi reless medium occupancy from the time the stream is admitted into the wi reless network to the time the deletion of stream. The timing diagram il lustrated in Figure 6 depicts the time the streams from the stations are admitted into and deleted from the network. Deletion and admission of s treams are performed through additional signalling from upper layer netw ork resource, 607. The time line indicated in (607), provides the time d ata stream are admitted into and exit from the wireless network. The sch eduled broadcast of the Selective Contention Information by the central controller is shown in the timing chart indicated by literal 608. Conten tions and the updates of the pointer (SCB_Ptr) derived from the value ca rries in the Selective Contention Backoff parameters are also shown the timing chart.

Updates of the Transmission Record parameters are based on the value use d are indicated in the 4 Selective Contention Period, 613, 614, 615 and 616. The updates illustrated in the 4 Selective Contention Period are pe rformed at the end of the Selective Contention Period. In this illustrat ion, the Selective Contention Period, 606, are bounded by two broadcast frames consisting of Selective_Contention_Information.

The timing line, marked by literal 609, illustrates the contention for m edium occupancy in the Medium Occupancy Contention Period. The resulting time chart, illustrated in time line (608), shows the compaction time o f Medium Occupancy periods resulted from the transmission Silence and Re -Scheduled of Medium Occupancy updates dictated by the process indicated by 501 of Figure 5. All stations and central controller have to enforce how the transmission records are updated. Time lines for Station A (610

), Station B (611) and Station C (612) give the instances of Medium Occupancy contention being admitted, re-scheduled and deleted. At different Selective Contention Period, it illustrates the instances of the different parameters of transmission records. In this example, deletion of Medium Occupancy by station A is based on Option 1 of process (316) of Figure 3.

For further illustrative purpose, time line (608) shows how termination of Medium Occupancy can take place by having station A send out a null packet (604) in the Medium Occupancy granted in earlier Selective Contention Period. This will allow the medium occupancy contention to take place among stations needing bandwidth on ad-hoc basis marked by literal (605). The amount of time for contention and transmission of data is bounded by the previous medium occupancy given up by station A.

【発明の効果】

By applying the present invention, a network device is become more QoS aware. The number of transmission permit required serving QoS streams are reduced. Contending of Wireless Medium is more scheduled and thus reducing the number of contention or collision as the wireless medium is shared by plural number of wireless station within a wireless network administered by a central controller. For a uninterrupted data stream transmission, the present invention allow contention based wireless medium to reserve for bandwidth thereby reducing the number of contention for reserved bandwidth to zero. Zero contention provides a constant transmission and reception behaviour at the transmitting and the receiving station respectively. Having a zero or extreme small contention period, the bad characteristic of stream arrival behaviour such as high jitter rate can be removed and allowing less complex interface and software control mechani

sm implementation in the layer above medium access controller.

【図面の簡単な説明】

Figure 1: A systematic process for Medium Dedication Schedule Generation (A systematic QoS awareness process for network device);

Figure 2: Finite State Machine for Transmission Permit Generator;

Figure 3: A High Level Message Sequence Chart for Wireless Stations and Central Controller operating during a Selective Contention period;

Figure 4: Timing Diagram of a typical Selective Contention Period;

Figure 5: A flowchart for updating Transmission Records;

Figure 6: Operations of Transmission Record by Wireless Station and Central Controller in a Selective Contention Period.

【符号の説明】

１０１　traffic classifier
１０３　rate controller
１０４、１１６　traffic shaper
１０８、１１８　transmission controller
１１２　admission control unit
１１４　traffic prioritiser
１２１　transmission permit generator

【書類名】　外国語図面

Figure 1

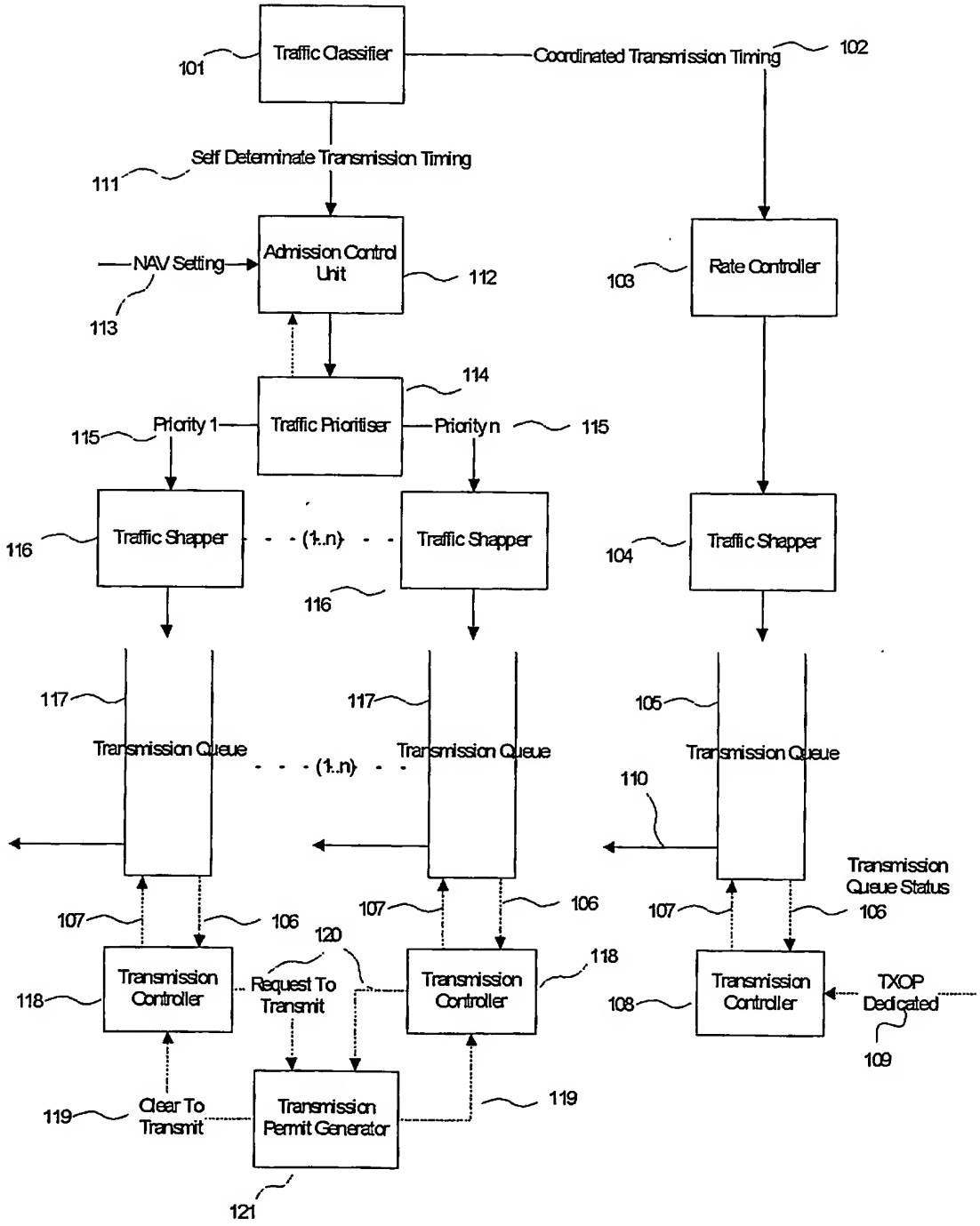


Figure 2

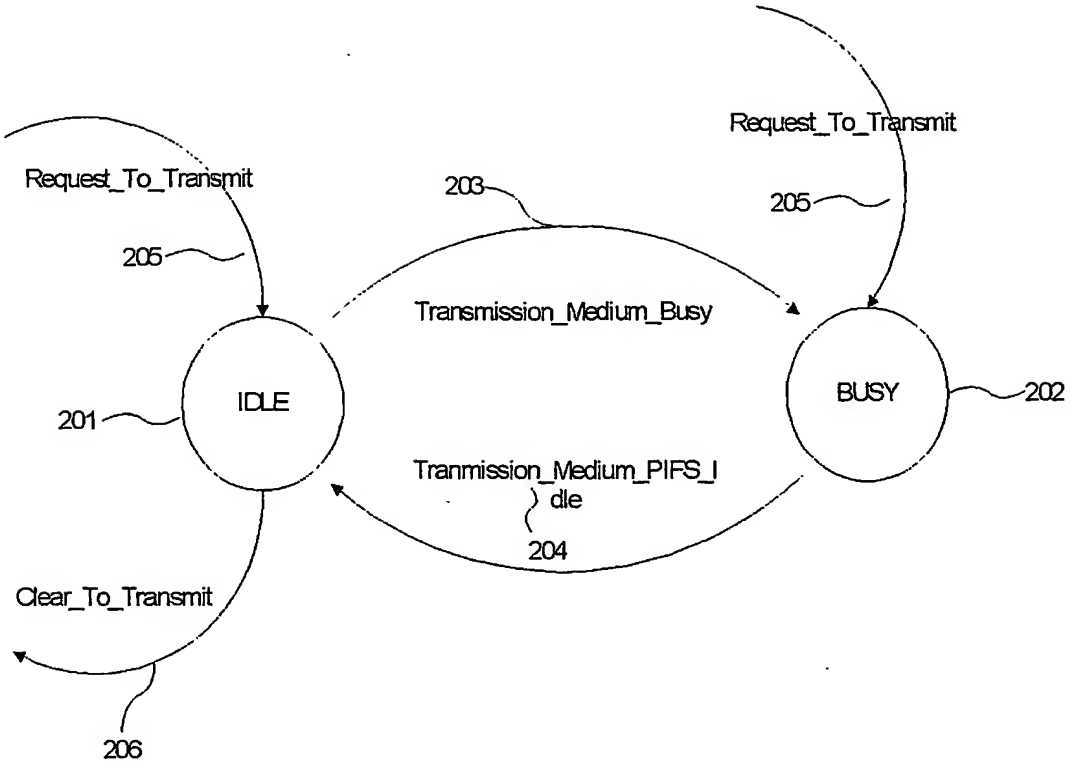

Request_To_Transmit
205
Request_To_Transmit
205
203
Transmission_Medium_Busy
IDLE
201
BUSY
202
Tranmission_Medium_PIFS_I
dle
204
Clear_To_Transmit
206

Figure 3

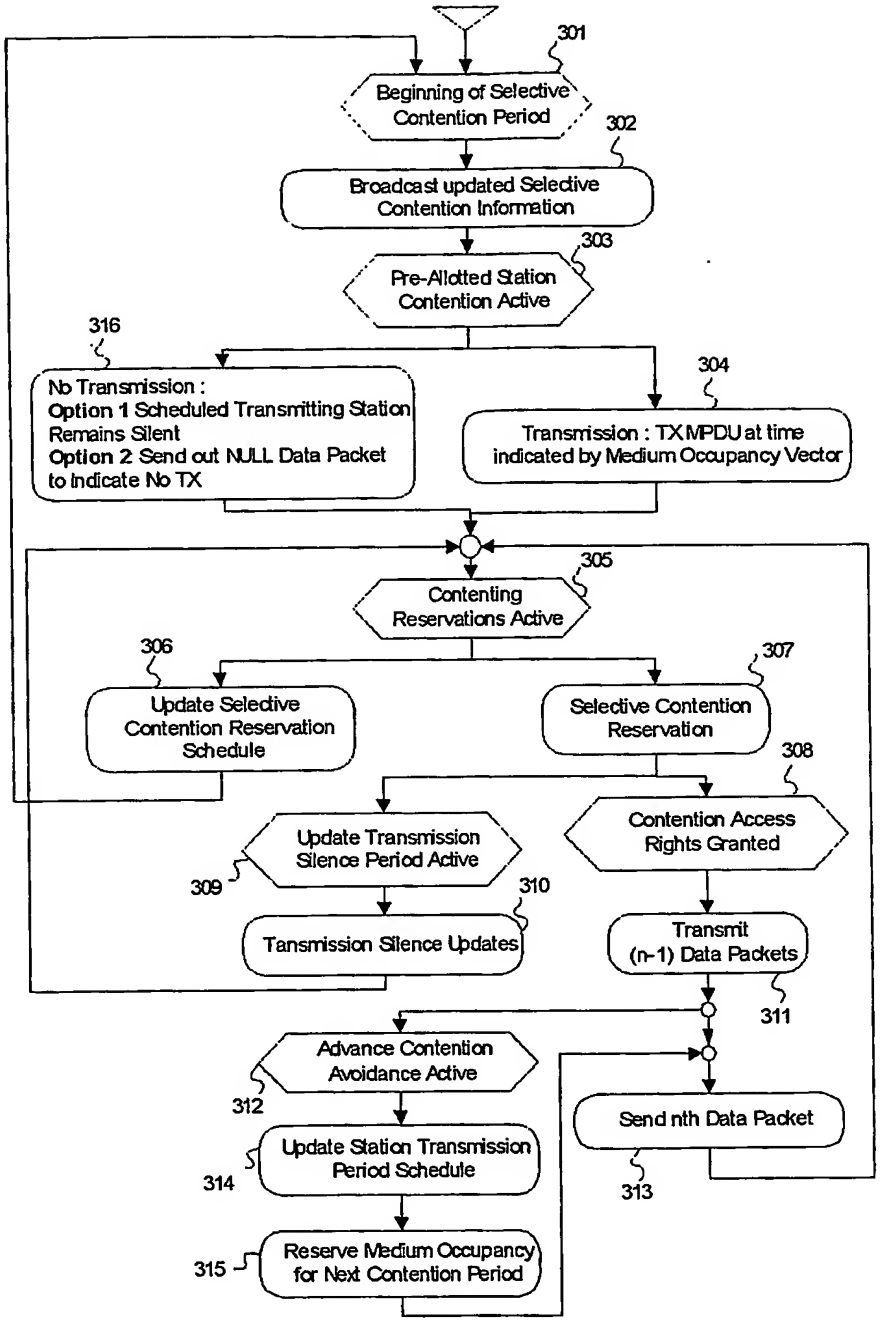

301
Beginning of Selective Contention Period
302
Broadcast updated Selective Contention Information
303
Pre-Allotted Station Contention Active
316
No Transmission :
Option 1 Scheduled Transmitting Station Remains Silent
Option 2 Send out NULL Data Packet to indicate No TX
304
Transmission : TX MPDU at time indicated by Medium Occupancy Vector
305
Contenting Reservations Active
306
Update Selective Contention Reservation Schedule
307
Selective Contention Reservation
308
Contention Access Rights Granted
309
Update Transmission Silence Period Active
310
Tansmission Silence Updates
Transmit (n-1) Data Packets
311
312
Advance Contention Avoidance Active
314
Update Station Transmission Period Schedule
315
Reserve Medium Occupancy for Next Contention Period
Send nth Data Packet
313

Figure 4

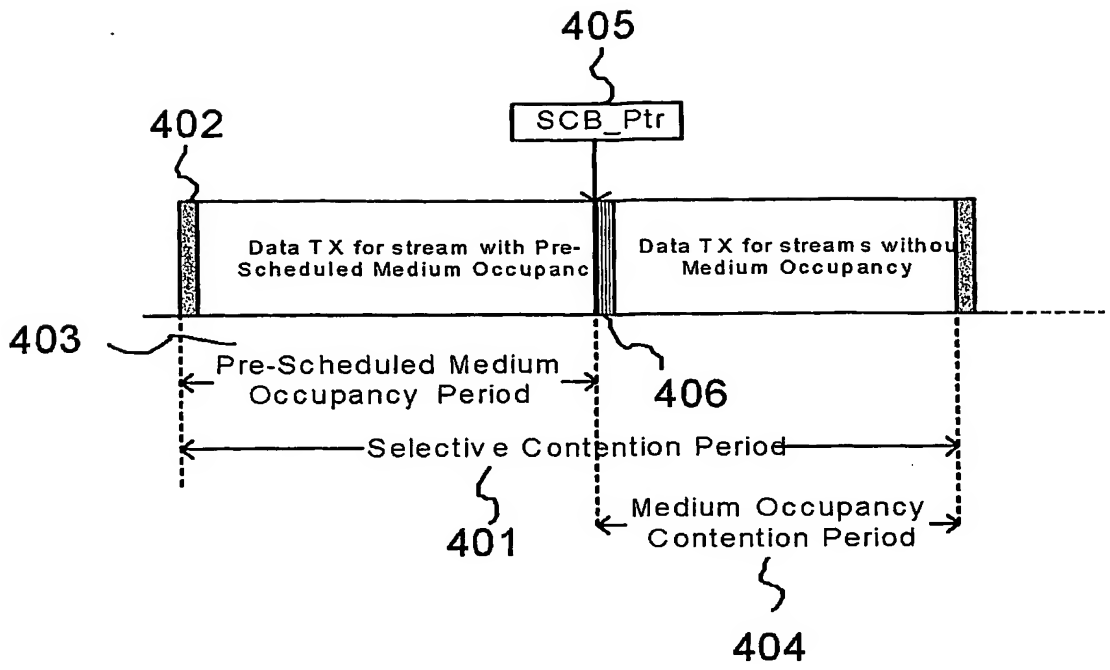

405
SCB_Ptr
402
Data TX for stream with Pre-Scheduled Medium Occupanc
Data TX for streams without Medium Occupancy
403
Pre-Scheduled Medium Occupancy Period
406
Selective Contention Period
401
Medium Occupancy Contention Period
404

Figure 5

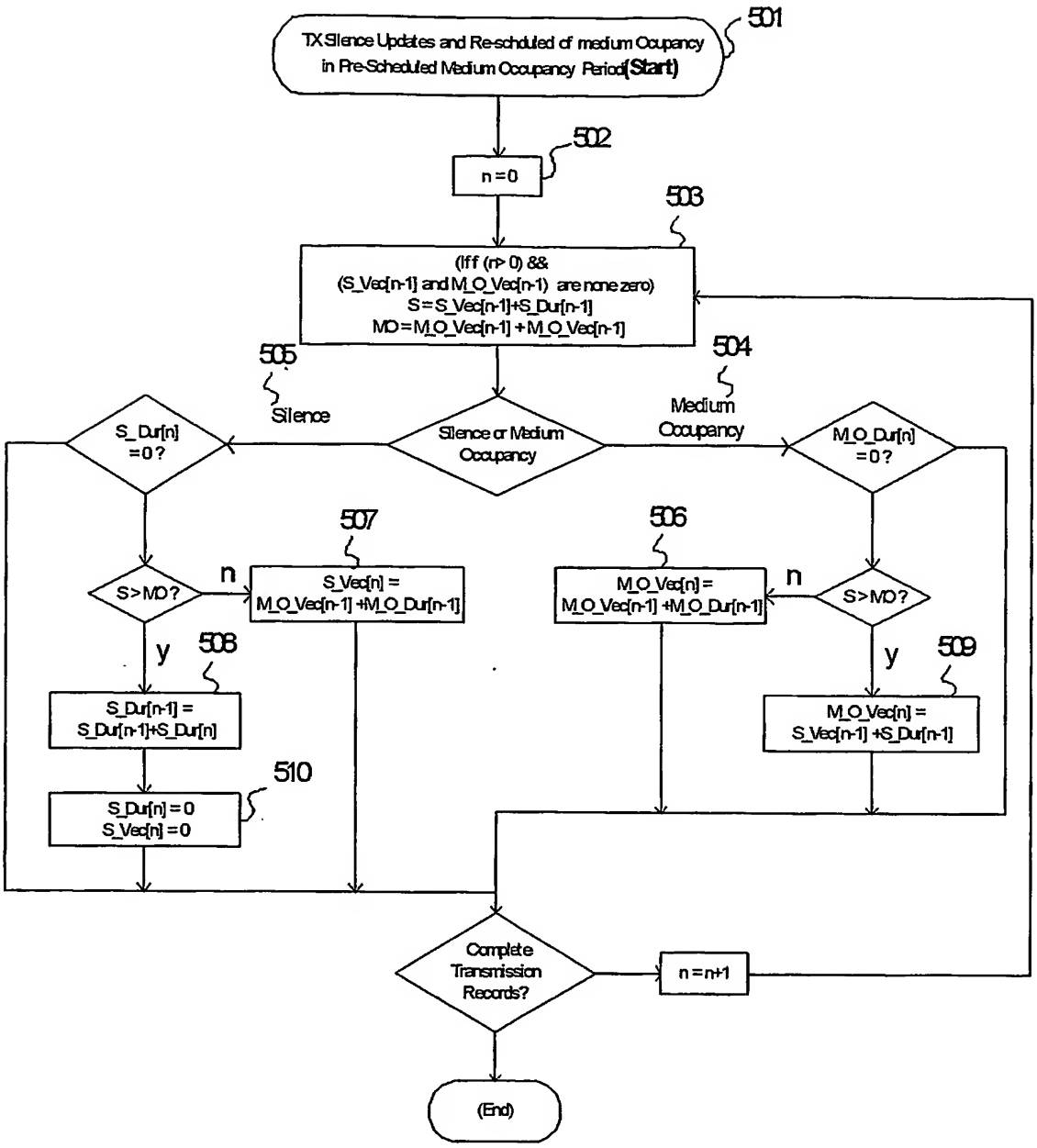
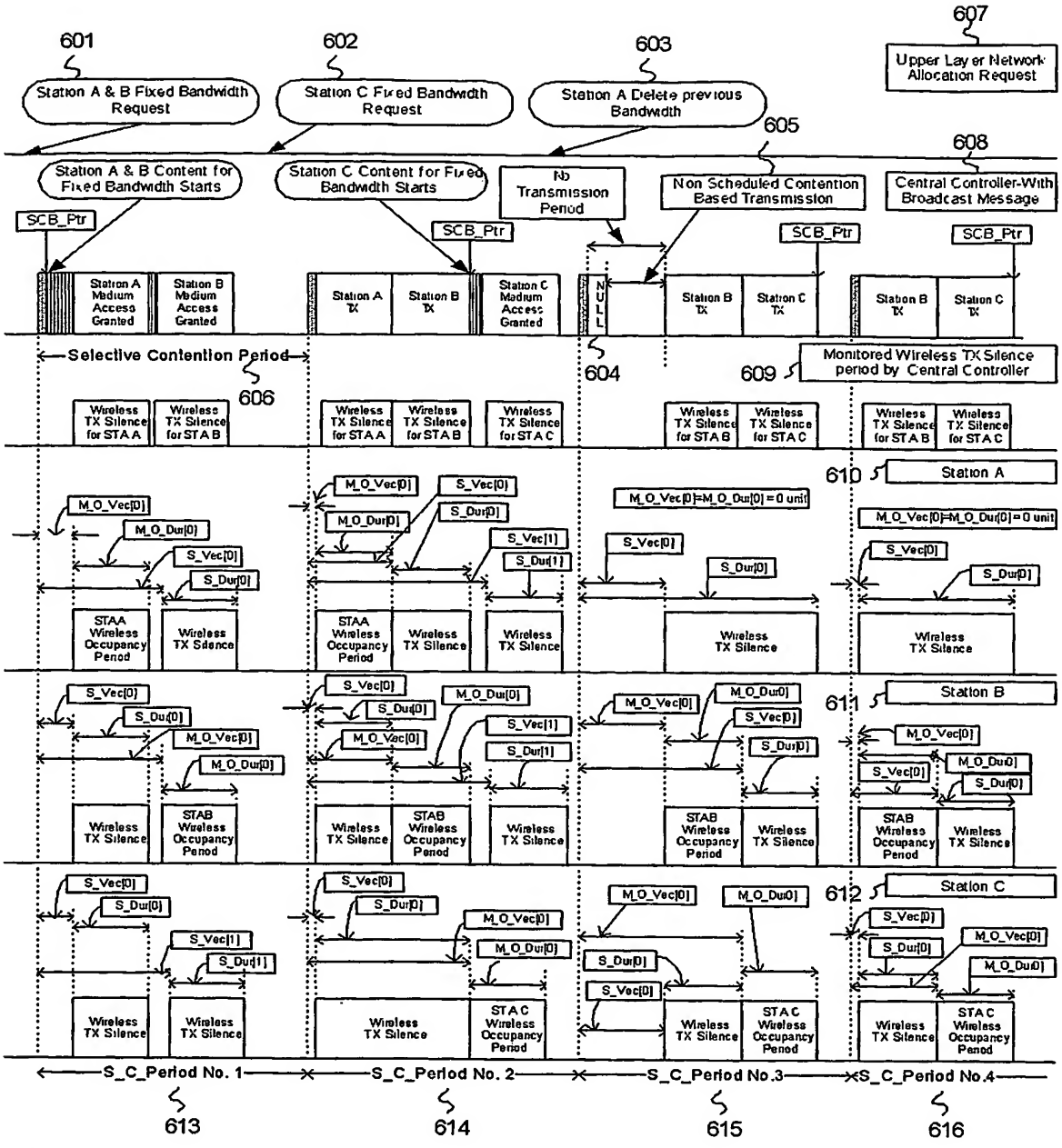

501
TX Silence Updates and Re-scheduled of medium Occupancy in Pre-Scheduled Medium Occupancy Period(Start)
502
n=0
503
(Iff (n>0) && (S_Vec[n-1] and M_O_Vec[n-1] are none zero) S=S_Vec[n-1]+S_Dur[n-1] MO=M_O_Vec[n-1]+M_O_Vec[n-1]
505
Silence
504
Medium Occupancy
Silence or Medium Occupancy
S_Dur[n] =0?
M_O_Dur[n] =0?
507
506
S>MO?
n
S_Vec[n] = M_O_Vec[n-1]+M_O_Dur[n-1]
M_O_Vec[n] = M_O_Vec[n-1]+M_O_Dur[n-1]
S>MO?
n
y
508
y
509
S_Dur[n-1] = S_Dur[n-1]+S_Dur[n]
M_O_Vec[n] = S_Vec[n-1]+S_Dur[n-1]
510
S_Dur[n]=0 S_Vec[n]=0
Complete Transmission Records?
n=n+1
(End)

Figure 6


601
602
603
607
Station A & B Fixed Bandwidth Request
Station C Fixed Bandwidth Request
Station A Delete previous Bandwidth
Upper Layer Network Allocation Request
605
608
Station A & B Content for Fixed Bandwidth Starts
Station C Content for Fixed Bandwidth Starts
Nb Transmission Period
Non Scheduled Contention Based Transmission
Central Controller-With Broadcast Message
SCB_Ptr
Station A Medium Access Granted
Station B Medium Access Granted
Station A Tx
Station B Tx
Station C Medium Access Granted
NCLL
Station B Tx
Station C Tx
Selective Contention Period
606
604
609
Monitored Wireless TX Silence period by Central Controller
Wireless TX Silence for STA A
Wireless TX Silence for STA B
Wireless TX Silence for STA C
610
Station A
M_O_Vec[0]
M_O_Dur[0]
S_Vec[0]
S_Dur[0]
S_Vec[1]
S_Dur[1]
M_O_Vec[0]=M_O_Dur[0]=0 unit
STAA Wireless Occupancy Period
Wireless TX Silence
611
Station B
STAB Wireless Occupancy Period
612
Station C
STAC Wireless Occupancy Period
S_C_Period No. 1
S_C_Period No. 2
S_C_Period No.3
S_C_Period No.4
613
614
615
616
Contention
Selective Contention Information Broadcast
SCB_Ptr
Selective Contention Backoff Pointer
NCLL
Delete Scheduled Wireless Occupancy

【書類名】　外国語要約書

【要約】

【課題】　The invention provides a systematic process to equip the network device to become QoS awareness.

【解決手段】　The presented invention provides a systematic QoS awareness process for network device. It enables data units of all traffic stream that the transmission is being coordinated are being emitted into a transmission queue that is being served in a First-In-First-Out fashion. Furthermore, traffic shaping is being performed on the emission of data units into transmission queue in a fashion to reduce the number of transmission permit required. For data streams to be transmitted by contention based medium access control, the present invention provides a methods and system for selective choose contention time and thus reducing the bandwidth wasted for contention or collisions.

【選択図】　図１

特願２００３－００４４９８

# 出願人履歴情報

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